JNCASR				
Graduate Research Internship Programme				
List Of Projects For GRIP, January-2024				
Sl No.	**Project Code**	**Unit**	**Faculty Member/Unit**	**Project Title with description**
1	BS-A	CPMU	Dr. Bivas Saha	**Title: Phase-change Materials for New Device.** **Overview:** The project aims to develop new phase change materials for emerging devices. Intricate relationship between structural, electronic and magnetic phase transition will be investigated**.**
2	BS-B	CPMU	Dr. Bivas Saha	**Title: Transdimensional Plasmonics.** **Overview:** The project aims to study the fundamental physics and materials science issues related to the transdimensional plasmonic materials. The project aims to develop new materials and devices for transdimensional plasmonic application**.**
3	KSN-A	CPMU	Prof. K.S. Narayan	**Title: Interfacing Cells-Tisssue-Organs with Biocompatible Organic Electronics.** **Overview:**The possibility of seamlessly integrating sensory organs with device components and circuits consisting of soft electronic materials on biocompatible substrates offers useful options to the monitor-enhance-augment natural response to various stimuli. The optoelectronic properties of these tailored-materials and substrates have recently been utilized in our laboratory as active triggers for neuronal stimulation. We have pioneered the use of these novel optoelectronic features of organic semiconductors as an interface to evoke neuronal signals (from retinal ganglion cells) in a blind retina of a developing chick-embryo. This possibility of triggering neuronal signals in a blind retina has opened up a route for utilizing these (intelligent) structures as a prosthetic element. These promising initial results require a systematic deeper understanding to enable promising route for vision restoration targeted in eye disorders such as retinitis pigmentosa and macular degeneration. Research problems and themes around this topic are also currently being pursued. Light-triggered biophysical events, electric field changes, and recordings are a common thread in many of these activities. These range of topic are truly interdisciplinary where multiple expertise and skillsets are put to use. Students who are interested in this topic and can contribute can be from any discipline and interests such as biomedical, biophysics, cell culture and development, neuroscience, small-signal measurement and analysis, microscopy, statistical techniques are welcome.
4	KSN-B	CPMU	Prof. K.S. Narayan	**Title: Predicting the Thirty-Year Performance of Solar Panels By Measurements and Modelling.** **Overview:** Large-scale deployment of photovoltaic (PV) panels across the world has led to a need for stringent tests and quality checks so that the PV panels can last the expected promise and performance for thirty years. Besides the economic implications, non-performing panels inundating our landscape and rooftops can become a huge potential environmental issue. A common range of methods like electroluminescence (EL), PL, high-resolution optical images, and thermography is utilized to identify the typical defects and their possible origin. We realize the inadequacy of these methods to completely sort the performance parameters with the obtained images. In this line of pursuit, we have introduced a method called light-beam induced current (LBIC) scanning technique, which can be utilized at large panel-dimension scales at reasonably high speed. LBIC is inherently quantitative and well suited to identify microscopic defects since it involves measuring the photocurrent in response to a local light beam. Besides building and fabricating these imaging scanners, we develop circuit-models to realistically represent the devices. Students who are interested in this topic and can contribute can be from any discipline and interests such as solar-panel analysis and assessment, signal measurement and analysis, imaging and microscopy, (big) data analysis and handling, and machine-learning skills are welcome.
5	EM-A	CPMU	Prof. M. Eswaramoorthy	**Title: Next generation electrocatalysis: Chemical assisted hydrogen evolution.** **Overview:** Hydrogen is a green fuel with high energy density and zero carbon footprints. Electrochemical route for synthesis of highly pure hydrogen fuel avoids the formation of by products like CO, CO2 (produced during commercial route of steam reforming) which adversely affect the activity and stability of electrodes in the fuel cell. Further, the oxygen evolution reaction occurring at the anode during water splitting primarily contributes to the high overpotentials (extra energy) of overall process. In order to overcome the high energy usage, chemical assisted hydrogen evolution can be employed wherein hydrogen will evolve at the cathode with simultaneous production of value-added chemicals (at the anode) at very low potentials. Various noble and non-noble metal-based catalysts have been studied for synthesis of high demand value-added chemicals like benzaldehyde, glucaric acid, acetaldehyde, etc. Considering this aspect, the major focus of this project will be designing electrocatalysts for oxidation of alcohols (aliphatic and aromatic), and biomass derived chemicals which not only show high performance towards HER but also show feasibility towards synthesis of economically viable and high demand products with high yield and selectivity. References: 1.H. Huang, C. Yu, X. Han, H. Huang, Q. Wei, W. Guo, Z. Wang, J. Qiu, Energy Environ. Sci., 2020, 13, 4990 2.WJ. Liu, Z. Xu, D. Zhao, XQ. Pan, HC. Li, X. Hu, ZY. Fan, WK. Wang, GH. Zhao, S. Jin, G. W. Huber, HQ. Yu, Nat commun., 2020, 11, 265

6	EM-B	CPMU	Prof. M. Eswaramoorthy	**Title 2: Design of efficient electrocatalyst as cathode for Zin-air Battery.** **Overview:** Our ever-growing energy demand has spurred the increase in development of energy storage devices. Li-ion batteries are the leading energy storage solution but is still suffering from insufficient energy density (<350 W h kg−1), high cost (~$150 kW−1 h−1) and potential safety risk. ZAB is larger theoretical energy density (1353 W h kg−1 excluding oxygen), low cost (<$100 kW−1 h−1) and inherent safety.[1] Zn–air batteries (ZAB) are arguably the only technically and economically viable solution for fast-charging Electric vehicles in the future. ZAB constitutes air cathode (electrocatalyst) where oxygen reduction (during discharging) and oxygen evolution reaction (during charging) occur. But the pursuit of electrically rechargeable ZAB pose limitation using state-of-the-art cathode electrocatalysts due to low energy efficiency on cycling under real working conditions. We plan to develop low loading of metal adhered on low-cost carbon material for a cyclable air cathode under meaningful test conditions.[2] Also, understanding of electrocatalyst during charge-discharge will be well studied via different in-situ studies. Resolving this roadblock can help us move a step closer to large-scale industrial and commercial deployment. References: [1]J. Zhang, Q. Zhou, Y. Tang, L. Zhang, Y. Li, Chem. Sci. 2019, 10, 8924–8929. [2]X. Zhu, C. Hu, R. Amal, L. Dai, X. Lu, Energy Environ. Sci. 2020, 13, 4536–4563.
7	TKM-A	CPMU	Prof. Tapas Kumar Maji	**Title 1: Post-synthetic modifications in MOFs and porous organic polymers for photocatalytic water and CO_2 reduction.** **Overview:** Our research work is focused on developing porous materials based on robust, efficient and cheap photocatalysts to realize visible-light-driven water and CO2 reduction reactions. We engineered pore surfaces of porous materials by grafting suitable chromophoric molecules through post-synthetic modification toward efficient photocatalytic performances. We are also involved in fabricating charge-transfer regulated coordination polymer gels wherein controlling the morphology of the self-assembled architecture is proven to be incredibly important to regulate the photocatalytic performances. Thus, in the broader picture, we are consistently looking to address a global concern of the energy crisis in an environmentally benign manner by developing novel porous materials as an efficient photocatalyst.
8	TKM-B	CPMU	Prof. Tapas Kumar Maji	**Title 2: Electroactive porous organic polymers as bi/tri-functional electrocatalyst and as cathode material for metal-air batteries.** **Overview:** We are involved in designing and developing novel redox-active porous organic polymers comprising conjugated microporous organic polymers (CMPs) and covalent organic frameworks (COFs). These materials not only displayed metal-free electrocatalytic property for oxygen reduction (ORR) as well as hydrogen /oxygen evolution reaction (HER and OER)but also found to be capable of in-situ stabilization of metal nanoparticles. The resulting composites have displayed electrocatalytic activity toward oxygen evolution reaction (OER) in addition to the ORR and HER, and thus, metal-air batteries were fabricated with them. In short, we perform a comprehensive study on designing and developing novel electroactive porous polymer materials and utilize them further to fabricate cheap and stable metal-air batteries for practical utility.
9	AS-A	CPMU	Prof. Sundaresan	**Title 1: Study of magnetically low-dimensional quantum materials.** **Overview:** Quantum materials are vaguely described as materials that do not follow the law of classic physics, e.g., quantum spin liquids, topological materials, etc. These materials can lead to the realization of many novel technologies, such as quantum computing, quantum communications, and highly encrypted quantum information. In this project, we will focus on 4f-elements-based low-dimensional quantum materials as a reduction in the degree of freedom for magnetic interactions can provide an ideal platform to explore exotic phases of quantum materials. Furthermore, a Jeff = ½ ground state can be realized in rare-earth-based systems due to the combined effect of crystal field and spin-orbit coupling, which is a prerequisite for various new quantum states.
10	AS-B	CPMU	Prof. Sundaresan	**Title 2: Exploring new superconductors.** **Overview:** Even after hundred years of discovery, understanding the physics of superconductivity remains a challenge. The huge applications of superconductors have been pushing the scientific community to understand the complex physics hidden there as well as looking for new superconductors with higher superconducting temperatures. This project offers an opportunity to synthesize new superconductors and investigate the properties of a few chalcogenides and alloys from bulk and microscopic perspective. This project includes synthesis through ARC Melting, Solid State Synthesis, High-Pressure Synthesis, bulk characterization by X-ray diffraction, magnetization, resistivity, hall effect, and specific heat capacity.
11	GUK-A	CPMU	Prof. G. U. Kulkarni	**Title: Building spiking circuits for AI systems.** **Overview:** Project work involves designing and making pulsing circuitry to feed to neuromorphic devices. Shaping the pulses and output signal processing leading to prototype development will be part of the project
12	GUK-B	CPMU	Prof. G. U. Kulkarni	**Title 2: Nano soldering of circuits.** **Overview:** Using a sophisticated instrument, circuits are to be built while drawing external connections using nano soldering techniques. Exploratory ideas of adopting self-assembly approaches are to be attempted.
13	TNC-A	EIBU	Prof. T.N.C. Vidya	**Title: Simulations to understand male elephant associations and reproductive tactics:** This project involves building individual-based simulations (in Matlab preferably) that model male elephant movement patterns. These simulations will be used to examine associations of adult males with other males and females and to compare these associations with results from the field. The simulations will also be used to understand the conditions under which musth as a reproductive tactic is advantageous under scramble and contest competition.
14	TNC-B	EIBU	Prof. T.N.C. Vidya	**Title: Simulations to model phylogeographic distributions:** A study of comparative phylogeography found various patterns of population genetic differentiation across the Palghat Gap. This project involves carrying out simulations to model populations with different attributes geographically separated and admixed for various periods of time, and examining the resultant intraspecific phylogeographic patterns and population genetic differentiation.

15	TNC-C	EIBU	Prof. T.N.C. Vidya	**Title: Estimating elephant mortality rate from identified carcasses:** This project involves extracting DNA from tissue samples obtained from elephant carcasses and genotyping individuals at microsatellite loci. These genotypes will be compared with those obtained previously from dung sampling of live, identified individuals, in order to identify the dead individuals. The proportions of carcasses that can be matched with identified individuals will be used in a statistical framework to estimate mortality rate.
16	AJ-A	EIBU	Prof. Amitabh Joshi	**Title 1: Male-female coevolution in the context of inter-locus sexual conflict** **Overview:** Studies of various aspects of reproductive behaviour and success in four sets of forward and reverse selected fruitfly populations wherein forward selection for rapid development to adulthood, and for early reproduction, led to the evolution of reduced sexual conflict levels. Using populations with selection reversed for either just rapid development, or for both rapid development and early reproduction, the project aims at extending our earlier studies that tried to differentiate the effects of the two selection pressures (rapid development versus early reproduction) on sexual conflict levels in the original forward selected populations**.**
17	AJ-B	EIBU	Prof. Amitabh Joshi	**Title 2: Larval competitive ability and reproductive success in early versus late enclosing individuals from fruit fly cultures subjected to larval crowding at high food amounts.** **Overview:** Past work in our lab has shown that eclosion from pupae is spread out over several hundred hours in fruitfly populations subjected to larval crowding at high food amounts, unlike what is seen when the crowding is experienced at low food amounts. With such a large eclosion spread, early eclosing and late eclosing individuals experience very different ecological conditions with respect to effective competition while feeding, and with regard to metabolic waste concentrations in the surface layer of food where feeding activity is concentrated. We have earlier seen differences in body size, with early eclosing individuals being larger adults than late eclosing ones. This project is a follow-up to those studies, to examine whether the differences in early and late eclosing individuals also have consequences for larval competitive ability and reproductive success, and whether the pattern of such effects differs between populations adapted for many generations to this form of crowding and their ancestral control populations that are routinely maintained at very moderate larval densities.
18	KRS-A	EMU	Prof. K. R. Sreenivas	**Title: Experimental Fluid Mechanics and Thermal Sciences.**
19	AK-A	ICMS/NCU	Dr. Abhishek Kumar	**Title 1: Elucidating slow light effect in the topological photonic crystal for on-chip applications:** **Overview:** Slow light effect in photonic systems is vital for science and technology, as it offers enhanced light-matter interactions and significantly reduces the photonic devices' footprint. The ability to control the slow light offer a multitude of potential applications in areas such as quantum information processing, optical switching, buffers, switching, storage, and modulations and advances the understanding of different domains of wave physics. Motivated by these considerations, numerous efforts have been made to realize the slow light effect using conventional photonic crystal (PC) waveguides and coupled-resonator optical waveguides. Nevertheless, most of them suffer from scattering loss when subjected to disorder and sharp bends. To address this challenge, recent advancements in photonic topological insulator offer a potential way. In this project we aim to delve into and comprehend the underlying mechanism behind topological slow light and develop on-chip devices for applications sensing and communication.
20	AK-B	ICMS/NCU	Dr. Abhishek Kumar	**Title 2: Ultrafast photonics using emergent materials.** **Overview:** Ultrafast optics is one of the important fields in science and engineering. Technology in this field plays an important role in a variety of applications, including femtosecond laser imaging, communication, and optoelectronic devices. Recently, due to excellent opto-electronic properties, low-dimensional materials have emerged as promising candidate for high-speed switches, energy efficient photonic devices. They provide a new research direction for the field of ultrafast optics. In this project, we aim to leverage the unprecedented properties of emerging materials to develop photonic and optoelectronic devices such as: •Low dimensional materials for sensing and communication •Integration of low dimensional material with metamaterials for high-speed modulation •Low dimensional material based optical switch
21	RV-A	ICMS	Prof. Ranjani Viswanatha	**Title: Magneto-optical properties of Cu doped CdZnSe quantum dot.** **Overview:** Magneto-optics is the use of magnetic field to influence light propagation. An understanding of the magneto-optical behaviour in quantum dots can provide specific information regarding the energetically accessible multiple spin state configurations of the semiconductor materials leading to possible spintronic applications. In this work, we plan to study the properties of Cu doped CdZnSe quantum dots. Specifically, we intend to look for effect of optical perturbation on the two spin states producing magnetically inequivalent excitonic states and their effects on spintronic applications as well as photo-induced magnetism.
22	RM-A	MBGU	Prof. Ravi Manjithaya	**Project 1 title:** Role of mitochondria in health and disease**.** **Overview: Mitochondria are vital double membrane enclosed organelles devoted to energy production, redox homeostasis, metabolism, innate immunity, and apoptosis among many others. There are several processes in a cell that ensure the persistence of a healthy mitochondria pool. One such process is "Mitophagy", a selective autophagy process involved in removing damaged mitochondria.** **Mitochondrial diseases are defined as a spectrum of clinically heterogenous genetic disorders caused by mutations in genes, either nuclear or mitochondrial, that encodes mitochondrial proteins. Our aim is to understand how autosomal dominant pathogenic variants of these genes affect mitochondrial function and mitophagy.** **Site-directed mutagenesis and cloning strategies will be adopted to produce the point mutations of the respective genes following which, they will be tested on cell lines. Additionally, biochemical and fluorescence microscopy-based approaches will be used to detect the progression of mitophagy and changes in mitochondrial morphology.**

23	BK-A	MBGU	Dr. Kushagra Bansal	**Title: Regulators of genome superstructure in the immune system.** **Overview:** The primary focus on this project is to understand the molecular basis of immune cell development and function. The molecular regulators of genome superstructure have been implicated in various immunological disorders; however, much remains unknown regarding their role in the immune system. We seek to answer this question using laboratory mouse as a model system. This project will involve experiments such as flow cytometry, imaging-based analysis of immune cell differentiation and analysis of omics data.
24	JH-A	NCU	Prof. Jayanta Haldar	**Title: Development of metal-chelating small antibacterial molecules which target multi-drug resistant bacteria.** **Overview**: The increasing prevalence of antimicrobial resistance and complicated infections has highlighted the need to explore for new therapeutic approaches. The aim of this project will be to develop metal-chelating synthetic small molecules which can target bacterial cell envelope as well as key bacterial resistance elements such as antibiotic-hydrolysing enzymes. The molecular design will incorporate features to ensure the high selectivity for bacterial killing over mammalian cells. These molecules will be synthesised through simple chemistry, purified, and characterised. Based on preliminary antibacterial activity and toxicity, lead molecule will be identified, which will then be tested for its detailed antibacterial activity against complicated infection phenotypes such as biofilms, metabolically repressed stationary phase and persister cells, intracellular bacteria, etc. The preliminary mechanism of action will also be investigated through biophysical studies.
25	JH-B	NCU	Prof. Jayanta Haldar	**Title: Development of antibacterial-hemostatic hydrogels to tackle deep-tissue infections.** **Overview:** The complicated nature of deep-tissue infections, the problems arising due to blood loss and delayed healing, coupled with the possibility of infection by AMR-resistant pathogens calls for the development of multi-functional biomaterials which can be used as anti-infective coatings for the wounds. Towards this goal, this project will aim to develop synthetic biocompatible polymers with potent antimicrobial activity. Following synthesis, characterisation and preliminary antimicrobial testing, best polymers will be identified and used for preparing a wound-healing haemostatic hydrogel. The hydrogel will incorporate components which possess haemostasis and angiogenesis properties. This hydrogel will be characterised, and its mechanical and biocompatible properties will be assessed. Following this, the hydrogel will be tested for its ability to show anti-infective and haemostatic properties.
26	BKS-A	NCU	Dr. Bani Kanta Sarma	**Title: Understanding the stabilities of polyproline helices.** **Overview:** The tertiary amide bond of proline (Pro) can adopt cis conformation more readily than the secondary amide bonds of other naturally occurring amino acids. Because of the facile cis-trans isomerization of the Pro amide bond, poly-Pro (poly-P) tracts can adopt either polyproline I (PPI, all cis amide) or polyproline II (PPII, all trans amide) helical conformation in solution in a solvent-dependent manner. Poly-P often forms left-handed PPII helical geometry in aqueous and other polar solvents such as trifluoroethanol but prefer a more compact right-handed PPI helical geometry in less polar and hydrophobic solvents such as n-propanol and other aliphatic alcohols. Unfortunately, unlike the α-helices and β-sheets, the origin of stabilities of PPI and PPII helices are poorly understood. We are focused on getting molecular level understanding of the conformational properties of PP helices through the design and synthesis of short poly-P tracts.
27	BKS-B	NCU	Dr. Bani Kanta Sarma	**Title: Rational design of synthetic collagen mimics for biomedical applications.** **Overview:** Collagen is the most abundant protein in animals and constitute ~70 percent of the dry weight of human skin. Abnormalities in collagen structures are associated with a wide variety of human diseases including arthritis. Collagen is useful in the regeneration of damaged tissue such as nerve, bone, skin, or vascular tissues. While natural collagen has many clinical advantages for such applications including biocompatibility, the use of human and animal-derived collagen presents potential hazards, especially the transmission of infectious agents from donor to donee. Therefore, simplified peptides or peptidomimetic structures having collagen-like properties for similar clinical applications present attractive alternatives. Our group is interested in strategies to design and synthesize hyperstable artificial collagen mimics and their self-assembled hierarchical structures such as nanofibers and hydrogels with potential biomedical applications.
28	RV-B	NCU	Prof. Ranjani Viswanatha	**Title: Synthesis and Optical Properties of dual doped lead free halide perovskite nanocrystals.** **Overview:** Recently lead-free halide double perovskite nanocrystals are emerging as an alternative to lead halide-based perovskites due to lead toxicity. Amongst all lead-free halide double perovskite NCs although Cs2AgInCl6 is extensively studied. However, transition metal doping in these nanocrystals has not been explored. Transition Metal doping is known to add several properties that are otherwise unavailable, by introducing midgap states in the host material. In this project, we plan to synthesize dual doped nanocrystals to study the dopant kinetics, as well as the interaction of mid-gap states on the optical properties of the system.

29	TG-A	NCU	Prof. T. Govindaraju	**Title: Multipronged chemical biology (organic and bioorganic chemistry) approaches to tackle Alzheimer's disease.** **Overview:** Alzheimer's disease (AD) is a progressive neurodegenerative disorder and a major contributor to dementia cases worldwide. AD is clinically characterized by learning, memory, and cognitive deficits. Multipronged and holistic approaches are pertinent to understand disease pathology, targeting multiple biomarkers and targets for developing effective diagnosis and therapeutics. Drug discovery (organic synthesis and biological study) efforts targeting multifaceted toxicity involving protein aggregation, metal toxicity, oxidative stress, mitochondrial damage, and neuroinflammation among others are pursued. Our research efforts are focused on diverse but integrated strategies to understand the disease pathology, discovery of new biomarkers and drug targets, rationally design and synthesis of multifunctional small molecules and peptide-based modulators targeting multiple pathological factors as future diagnostic and drug development strategies.
30	TG-B	NCU	Prof. T. Govindaraju	**Title 2: Theranostics (Organic synthesis and screening for diagnostic and therapeutic activity)** **Overview:** Theranostics essentially denote the concept of combining therapeutic and diagnostic modalities to provide a holistic solution for disease management. Theranostics is also referred to as diagnostic therapy, wherein molecular and material tools for non-invasive treatment and diagnostic imaging are strategically embedded in a single system, which facilitate disease staging, treatment planning and therapeutic efficacy. Theranostics anticipated to revolutionize the practice and adaptation of personalized medicine to tackle chronic disease conditions like cancer and neuronal disorders. Our research projects are aimed at developing (synthesis and screening) small molecule-based theranostic tools.
31	SJB-A	NCU	Prof. Subi J. George	**Title: Morphological control over higher hierarchical structures of supramolecular polymers through realization of secondary nucleation event.** **Overview:** In recent years supramolecular polymers emerge as an extreme interest to the science community for their wide range of applications in optoelectronics, photovoltaics, nanotechnology and photocatalysis. For that, it requires an advance level of structural and morphological control over the polymers for tuning their desired properties. Over the last few years of our understanding on the primary and secondary nucleation events that occur during the polymerization process, reveals exceptional possibility to tune structure and morphology of supramolecular polymers, which is other way not possible to achieve. In this project we are going to have more deeper understanding on the role of primary and secondary nucleation events during the supramolecular polymerization process to get desired morphological control (such as making coaxial heterostructures, organic p-n junctions) and use them in photocatalysis, optical wave-guiding and optoelectronic materials. This project summarises the challenge of combining the design of novel molecules, synthesis and elucidating their properties in real time applications. The students in this project will be trained in the research areas of organic synthesis and various spectroscopic (UV, PL and CD) and microscopic techniques. References: J. Am. Chem. Soc. 2021, 143, 11777–11787; J. Am. Chem. Soc. 2022, 144, 11306–11315
32	SJB-B	NCU	Prof. Subi J. George	**Title 2: Development of Arylene Diimide Based Phosphors for Ambient Triplet Harvesting.** **Overview:** Organic molecules that can emit from their triplet states have received considerable attention in the recent past due to their applications in multiple fields such as OLEDs, sensors, and so on. Added advantages offered by phosphorescence imaging that outweigh the shortcomings of fluorescence imaging further augments their importance in biological realm as well. Over the last few years, we have been working in developing suitable phosphors with wide range of emissions and long-lived triplets by adopting various strategies such as crystallization, using polymers and inorganic scaffolds. In this project, we intend to develop organic phosphors based on arylene diimides by appropriate structural modifications. For further details, refer to our latest publications: Angew. Chem. Int. Ed. 2021, 60, 12323-12327; J. Am. Chem. Soc. 2022, 44, 10854-10861; Chem. Sci. 2022, 13, 10011–10019. Students in this project will be trained in the synthesis of organic molecules, and their spectroscopic characterization including UV-Vis absorption and fluorescence techniques.
33	PS-A	NCU	Dr. Premkumar Senguttuvan	**Title: Towards Realization of High Energy Density Phosphate Cathodes for Sodium-ion Batteries.** **Overview:**The pursuit on high energy density cathodes for sodium-ion battery application has become intense in order to improve the energy density overall battery system. Phosphate cathodes are preferred due to their high intercalation voltages, chemical and thermal stabilities. However, they suffer from limited storage capacities owing to electrochemical inactive phosphate units. A plausible way to improve their storage capacity is to introduce multi-electron redox centers in the framework. Herein, we will attempt to introduce multi-electron redox centers in NASICON class of materials through alio- and iso-valent chemical substitutions. These substitutions are expected to tune electronic and (local)crystal structures, thereby enhancing overall performance metrics of cathode materials. References : 1) C. Masquelier, L. Croguennec, Chem. Rev.2013, 113, 6552. 2) S. Ghosh, N. Barman, M. Mazumder, S. K. Pati, G. Rousse, P. Senguttuvan, Adv. Energy Mater. 2019, 1902918.

34	PS-B	NCU	Dr. Premkumar Senguttuvan	**Title: Development of Long-Life Zn Metal Anode for Rechargeable Aqueous Zinc-metal.** **Overview:** Zinc metal anode has several advantages including higher volumetric energy density (5854 mAh L-1) and suitable equilibrium potential of (-0.76 V vs SHE) which enables safer operation in aqueous electrolytes.1 However, its practical application faces several issues including 1) dendrite formation, 2) Zn corrosion and hydrogen evolution.2 Whilst the former issue results in lower Coulombic efficiencies and short-circuit of battery, the latter generates “dead zinc” which causes cycling instability and battery inflation/electrolyte leakage. This project will survey various classes of additives to tune the aqueous Zn2+-ion electrolyte properties, thereby enabling long cycle life Zn metal anodes. References:1)S. Guo, L. Qin, T. Zhang, M. Zhou, J. Zhou, G. Fang and S. Liang, Energy Storage Mater., 2021, 34, 545–562. 2) 20 Q. Yang, Q. Li, Z. Liu, D. Wang, Y. Guo, X. Li, Y. Tang, H. Li, B. Dong and C. Zhi, Adv. Mater., 2020, 32, 2001854
35	SSA-A	NCU & CPMU	Dr. Sarit S. Agasti	**Title: Super-Resolution Fluorescence Imaging Fluorescence microscopy is a powerful tool for exploring molecules in biological system.** **Overview:** Specifically the invention of super-resolution microscopy techniques enabled visualization of molecules beyond the diffraction limit of light. However, currently available techniques are either difficult to implement or require expensive instrumentation. We are interested in developing new super-resolution imaging strategies based on chemical probes (for example, DNA) that are easy to implement and provide high multiplexing capability. This project will deal with single molecule image acquisition and subsequent development of image processing algorithm.
36	SSA-B	NCU & CPMU	Dr. Sarit S. Agasti	**Title 2: Selective Chemical Reactions in Living System.** **Overview:** Performing selective chemistries in biological systems such as in cells or in living organisms is a challenging but highly functional objective. The ability to chemically conjugate functional groups such as fluorochromes and affinity tags in a site-specific manner would allow a wide variety of biomolecules to be specifically labeled and imaged in their native cellular environment, providing an alternative to a genetically encoded fluorescent protein-based method. This project will be oriented towards developing new synthetic chemistry concepts for labeling and tracking specific biomolecules as they function in vivo. We will be designing these strategies based on biorthogonal reactions; broadly refer to the chemical reactions that can be performed in living systems without interference from the biological milieu.
37	KB-A	NCU	Prof. Kanishka Biswas	**Title 1: Thermoelectric: Converting Waste Heat to Electricity.** **Overview:** Nearly ~65 % of utilized energy is being lost as waste heat. Thermoelectric materials can convert waste heat into electrical energy, and thus can play an important role in future energy management and energy crisis. Current challenges in thermoelectric research include (a) synthesis of new high-performance thermoelectric materials, (b) decoupling of electronic and thermal transport, and (c) module/device development for power generation. Here, we will be designing new materials and enhancing the thermoelectric properties of inorganic solids by reducing thermal conductivity and improving the power factor, thereby increasing the dimensionless figure of merit, zT.
38	KB-B	NCU	Prof. Kanishka Biswas	**Title 2: Water Purification: Capturing Heavy Metal Ions from Polluted Water.** **Overview:** Clean water is of vital importance for humans; still, more than one billion people lack access to it. Rapid industrialization and the development of nuclear energy have led to the discharge of heavy metal ions and radionuclides into water resources. Current challenges in capturing these toxic metal ions include synthesis and design of a prototype cartridge with a novel stable low-cost material which can work in wide pH range with fast kinetics, large adsorption capacity, and is capable of removing heavy metal ions selectively from water in ppb level, which is below the drinking water tolerance limits given by USA-EPA government. In this project, we will be designing new two and three-dimensional materials to capture arsenic, lead, cadmium, mercury and other toxic ions from water and study the adsorption properties in detail
39	SV-A	NSU	Prof. Sheeba Vasu	**Title: Bioinformatic analysis of genome sequences of morning and evening chronotypes of Drosophila melanogaster.** **Overview:** Chronotypes or ‘time-types’ are evident in human populations based on the innate preferences for sleep and waking, some of us are early risers while others are late sleepers. We have created populations of fruitflies with divergent timing of emergence as a proxy of early and late chronotypes with the goal of understanding the underlying genetic and physiological basis for such divergent traits. Through this GRIP project, we will extend ongoing studies on whole-genome sequence data to uncover signatures that may reveal pathways by which such contrasting timing is achieved. This will be a collaborative study between the labs of Sheeba Vasu (NSU) and Kushagra Bansal (MBGU).

40	SV-B	NSU	Prof. Sheeba Vasu	**Title: Role of gap junctions in modulating Drosophila circadian locomotor activity.** **Overview:** Drosophila circadian pacemaker neuronal circuitry is extensively studied but the role of electrical synapses composed of gap junction proteins Innexins is relatively poorly understood. The project will involve genetic, behavioural, immunohistochemical studies which are aimed towards clarifying our current understanding of the involvement of Gap junction genes – Innexin1-8. Students will train in fly genetics, behavioural analyses and immunohistochemical methods.
41	NSV-A	TSU	Prof. N.S. Vidhyadhiraja	**Title: Theoretical and computational Modelling of a neuromorphic device.** **Overview:** The project aims to investigate, using theoretical and computational methods, memory formation, memristor functions, and computing in neuromorphic devices. To know more about neuromorphic computing, please read the publicly available articles below (not from our group): https://www.nature.com/articles/s43588-021-00184-y and https://www.zdnet.com/article/what-is-neuromorphic-computing-everything-you-need-to-know-about-how-it-will-change-the-future-of-computing/
42	KJ-A	TSU	Prof. Kavita Jain	**Title: Traveling waves in evolutionary dynamics.** **Overview:** Traveling wave solutions of certain partial differential equations are those that travel with some speed while maintaining the shape of the solution and arise in various contexts ranging from reaction-diffusion systems and evolving populations. The broad aim of this project is to review the known theory and its connection to experiments and extend the previous results to new situations. Specifically, we are interested in understanding how the spatial structure modifies the signatures of selection in stochastic models of evolution.
43	SS-A	TSU	Prof. Srikanth Sastry	**Title: Investigation of dynamics and rheology of confined glasses and liquids in heterogeneous media.** **Overview:** The propagation and attenuation of sound modes in heterogeneous media is important in a variety of contexts, such as seismic waves in the earth's mantle. The relevant structures may be thought of an polycrystalline solids with grain boundaries whose dynamic and phase behavior may be different from the crystalline domains. With the view of understanding the propagation of sound modes (in particular shear modes) and their attenuation in such systems, and eventually the long-time rheology, the project will undertake a series of computational investigations. With the scenario in mind that the grain boundaries are either amorphous solids or liquids, the project will initially be concerned with generating molecular dynamics trajectories from which the sounds modes may be characterized, as a function of temperature. As visco-elasticity may be of relevance for the phenomena of interest (but with very large viscosities that cannot be easily computed with conventional computational methods), the project will also consider recent proposals for computing ultra-large viscosities reliably and explore new methods.